

OBSERVATION OF $CH A 2_{\lambda} \rightarrow X^2\Pi$, AND $B^2\Sigma^+ \rightarrow X^2\Pi$, EMISSIONS IN GAS-PHASE COLLISIONS OF FAST $O(^3P)$ ATOMS WITH ACETYLENE

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Optical emissions in single-collision, beam-beam reactions of fast (3-22 eV translational energy) $O(^3P)$ atoms with C_2H_2 have been measured in the wavelength range 300-850 nm. Two features were observed, one with peak wavelength at 431 nm, corresponding to the $CH A 2_{\lambda} \rightarrow X^2\Pi$, transition, and a second weaker emission in the range 380-400 nm corresponding to the $B^2\Sigma^+ \rightarrow X^2\Pi$, transition. Both emissions were fit to a synthetic spectrum of $CH(A)$ and $CH(B)$ at a given vibrational temperature T_v and rotational temperature T_r , (Fig. 1). The energy threshold for the $A \rightarrow X$ emission was measured to be 7.3 ± 0.4 eV (LAB) or 4.5 ± 0.2 eV (CM). This agrees with the energy threshold of 7.36 eV (LAB) for the reaction $O(^3P) + C_2H_2 \rightarrow CH(A) + HCO$. The atomic-oxygen source, target region, and spectrometer system used in these measurements were the same as those used previously in single-collision, beam-beam collision studies of HCN [1]. The retarding-potential difference method (RPD) used herein was also described in Ref. 1.

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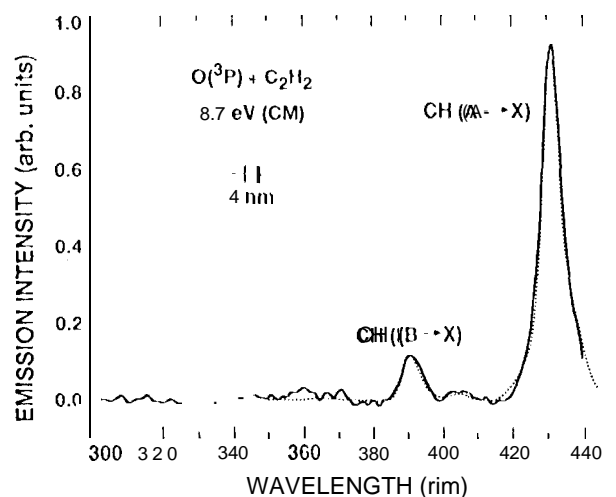


Figure 1. Measured (---) and simulated (■■■■) spectrum of the $CH A 2_{\lambda} \rightarrow X^2\Pi$, and $CH B^2\Sigma^+ \rightarrow X^2\Pi$, emissions at 8.7-eV CM energy. Simulations are for $T_v = 10000$ K, $T_r = 5000$ K for the A state; and $T_v = 2500$ K, $T_r = 1000$ K for the B state.

References

- [1] O. J. Orient, A. Chutjian, K. E. Martus and E. Murad, *Phys. Rev. A* 48, 427 (1993).

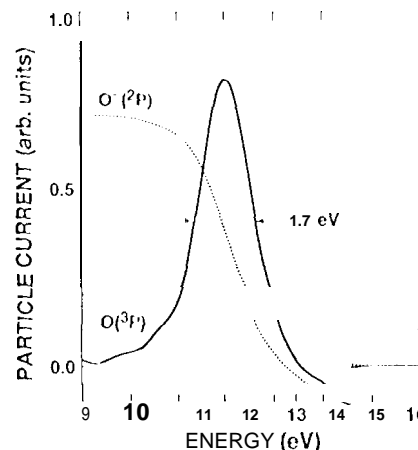


Figure 2. Energy distribution of $O(^2P)$ at an ion current of $10.8 \mu A$. Shown are the O^+ and the $O(^3P)$ distributions, the latter obtained from the derivative of the RPD curve, corrected for variation of detachment efficiency across the line width,

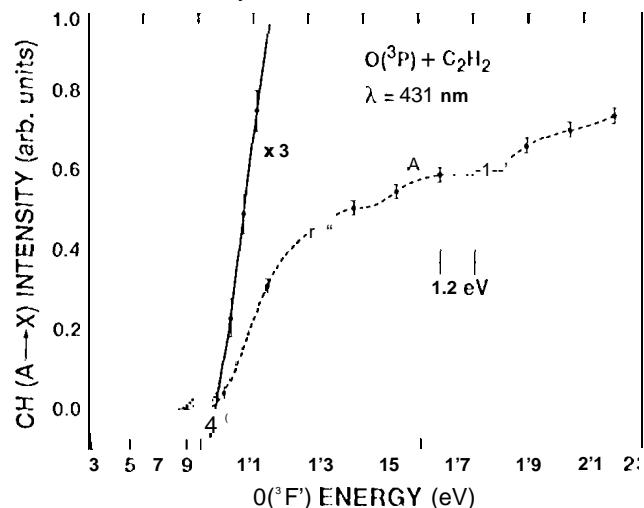


Figure 3. Excitation of the $A \rightarrow X$ emission at 431 nm as a function of $O(^3P)$ LAB energy (curve A), deconvoluted from the energy distribution of the $O(^3P)$ atoms (1.2 eV FWHM here). The excitation threshold at 7.3 eV (LAB, from $A \times 3$ curve and arrow) is for the reaction to form $CH(A) + CHO(X)$. Dotted portion (●●●) shows effects of the high-energy tail in the $O(^3P)$ energy distribution,